A Multi-Faceted View of GPM GV in the Post Launch Era

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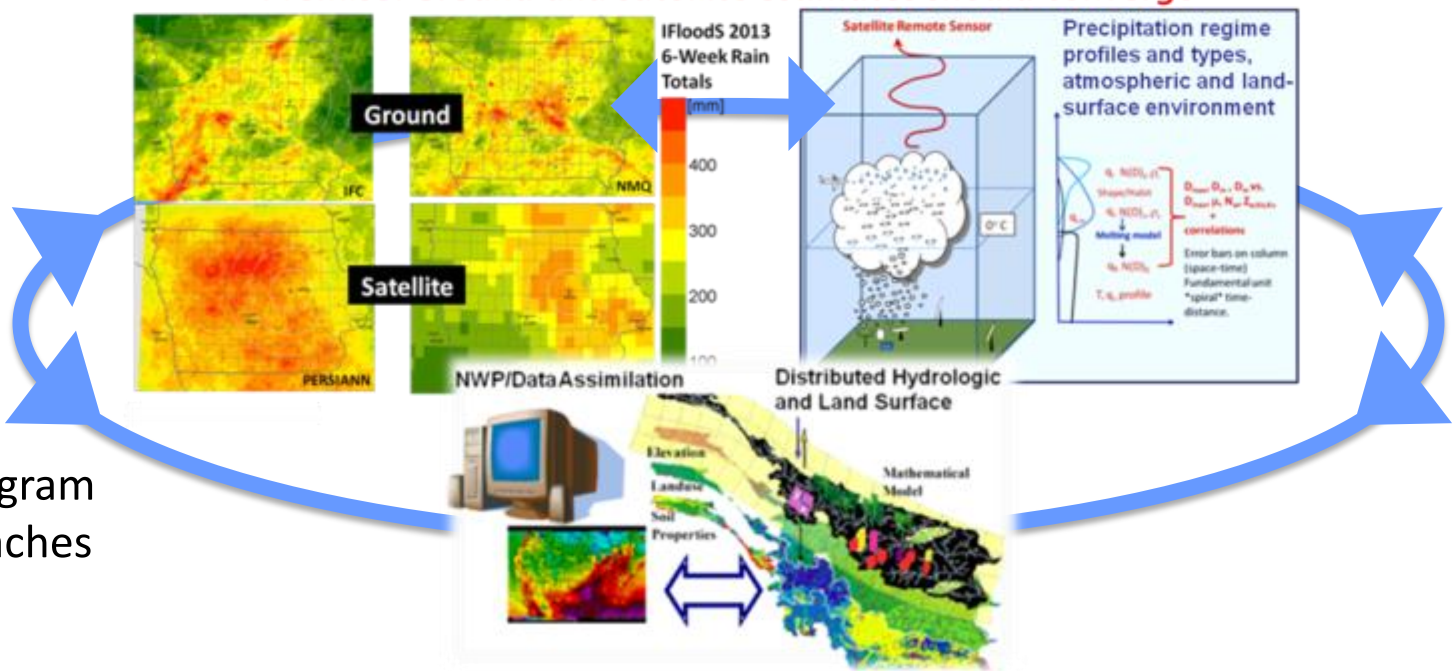
Framework

Premise: Ground and satellite estimates should converge



GV Program Approaches

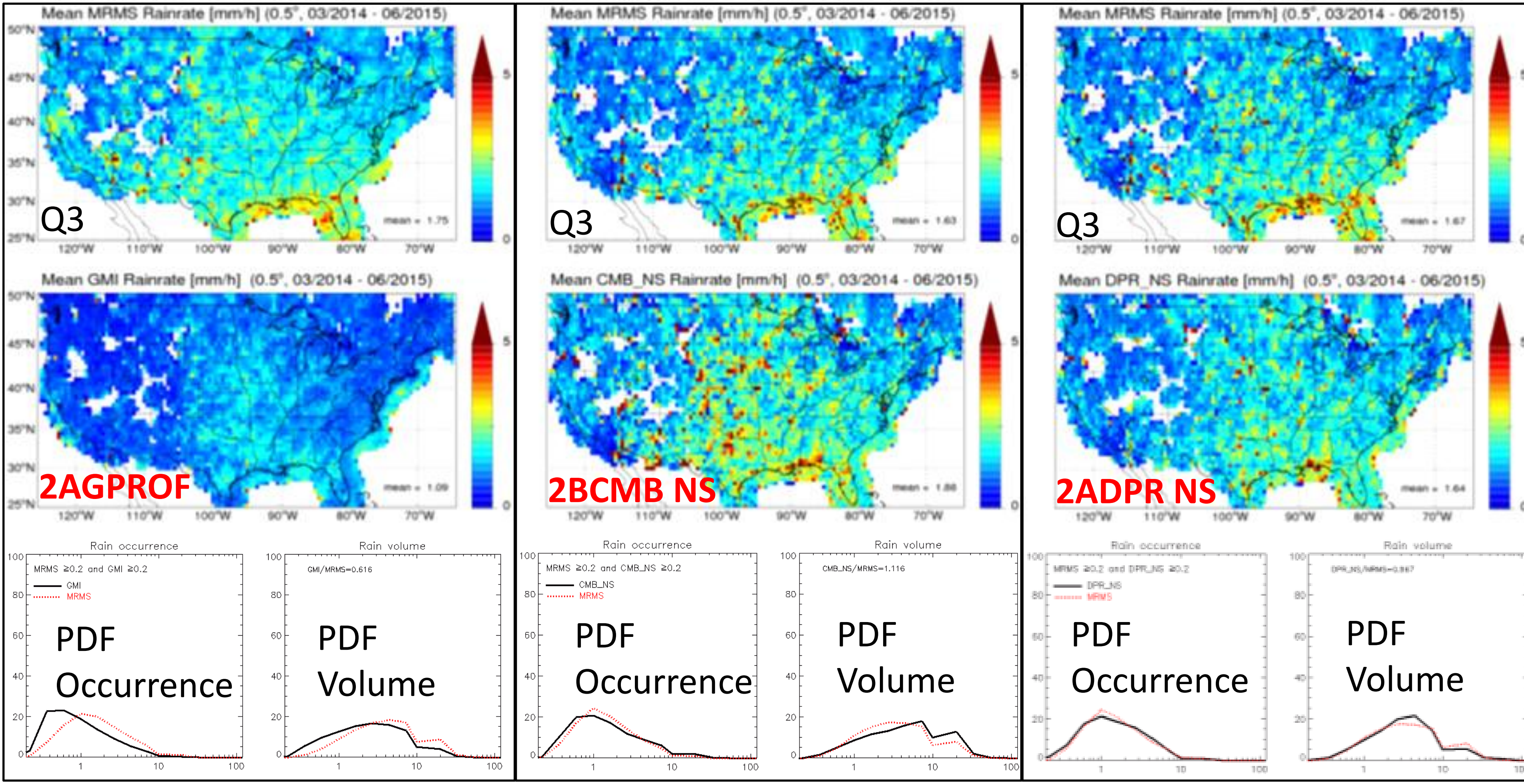
GPM Core L1 Science Requirements

- DPR: quantify rain rates between 0.22 and 110 mm hr-1, demonstrate the detection of snowfall at an effective resolution of 5 km.
- GMI: quantify rain rates between 0.22 and 60 mm hr-1 and demonstrate the detection of snowfall at an effective resolution of 15 km.
- Core observatory radar estimation of the Dm to within +/- 0.5 mm.
- At 50 km resolution, instantaneous rain rate estimate with bias and random error < 50% at 1 mm hr-1 and < 25% at 10 mm hr-1, relative to calibrated GV

Instantaneous Rain Rate: Product Consistency Checks (V3)

http://gpm-gv.gsfc.nasa.gov/

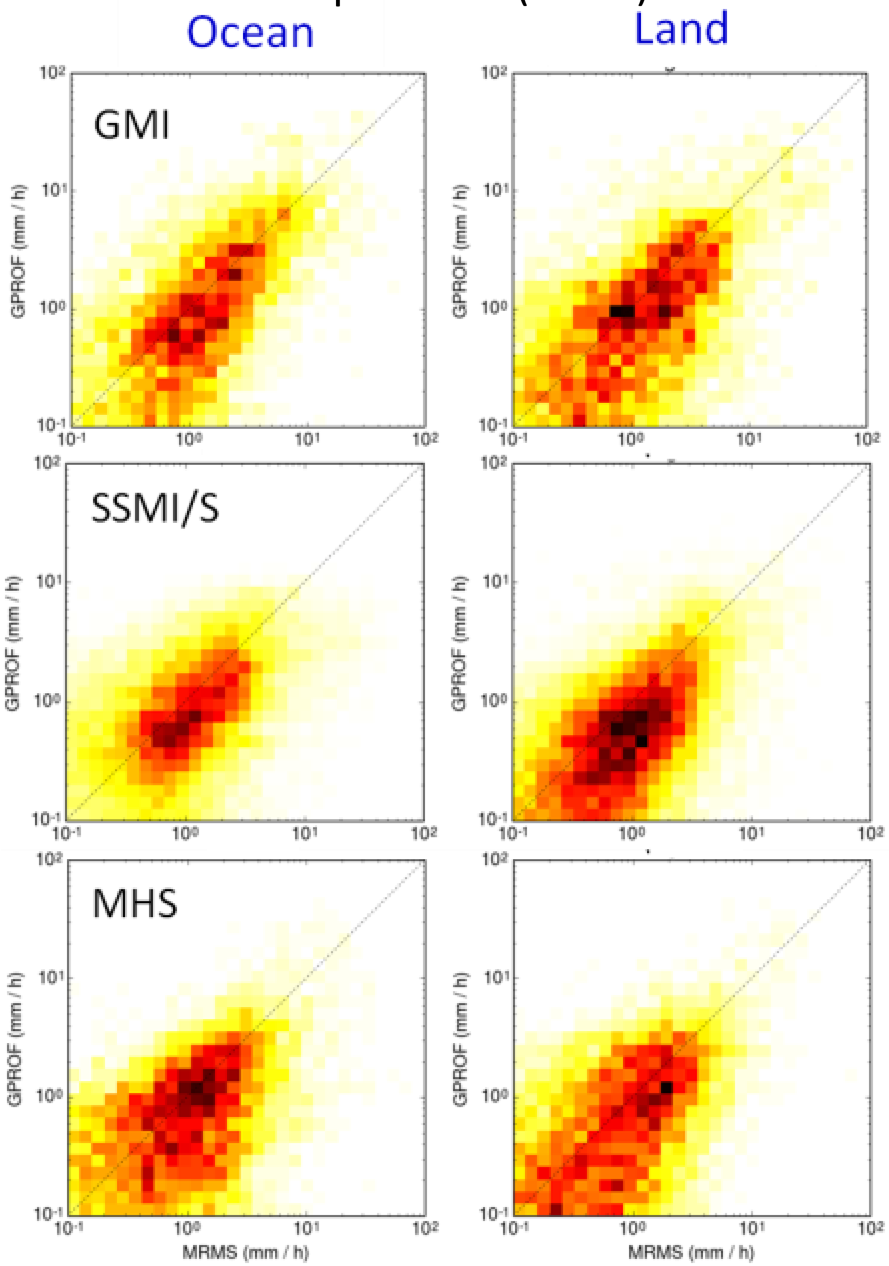
MRMS (Q3) and GPM: 03/14 to 06/2015 : 0.5° grid; Liquid only; RR Threshold > 0.2 mm/hr;



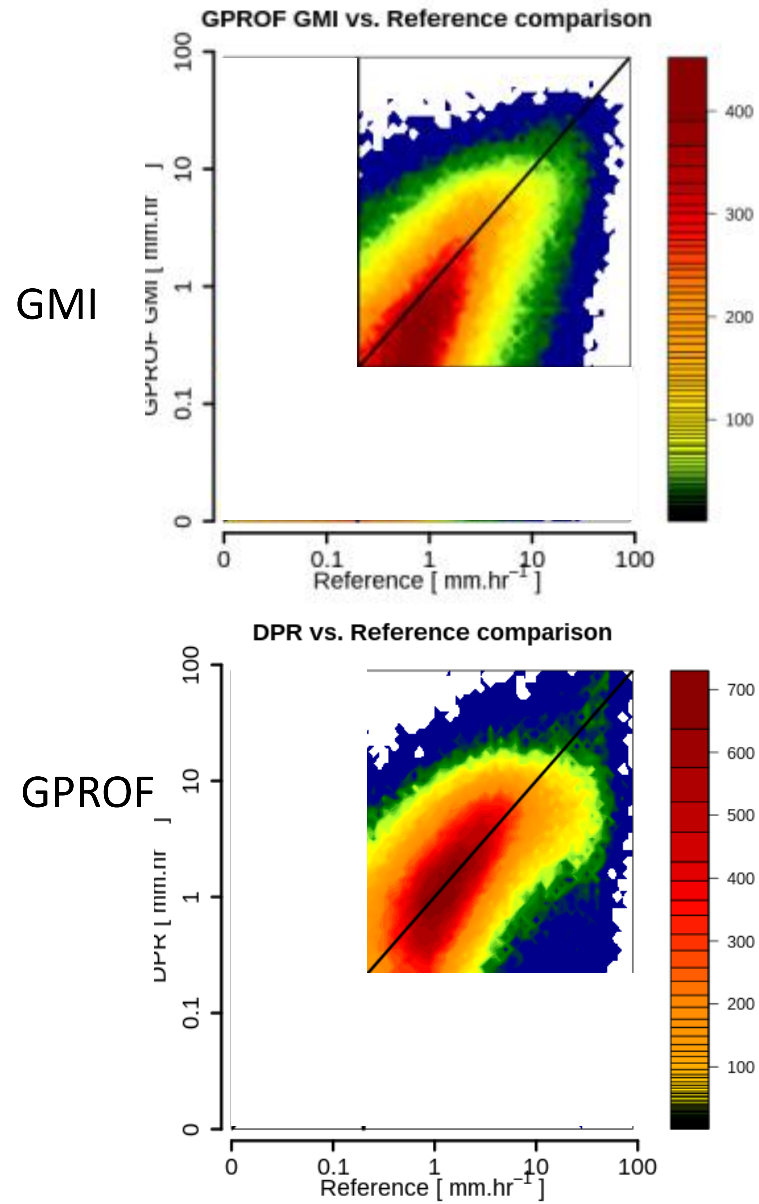
- Matching GPROF values are biased slightly lower relative to DPR, CMB and MRMS Products. CMB NS, DPR, MRMS similar- CMB NS a bit higher in mean.
- ***Level 1 Requirements:*** *Mean* relative error generally falls within requirements; RMSE……

Minimal/no rain rate thresholds, footprint scales, and "reference" MRMS

April 2015 (J. Tan)



July-August 2015 (P. Kierstetter)

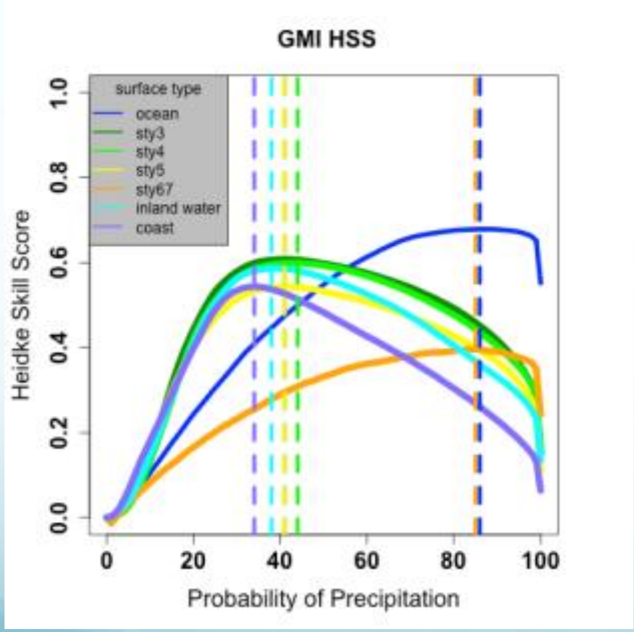


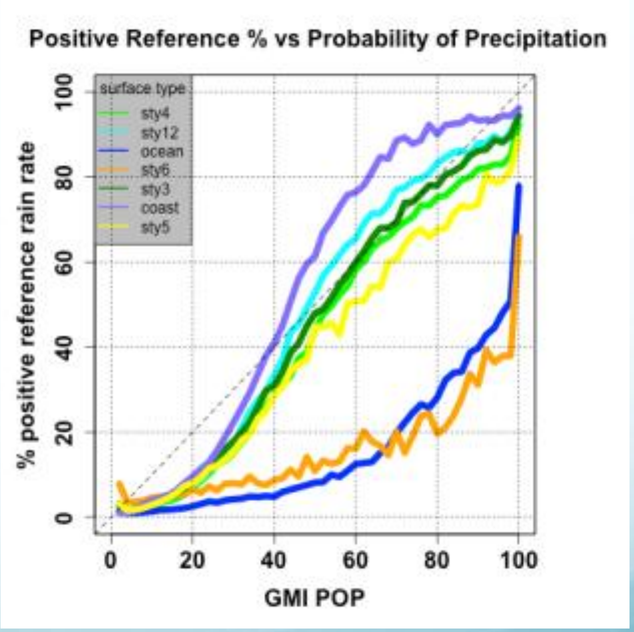
GPROF lower rain rate thresholding approach and regimes

GPM-era POP variable

$$HSS = \frac{2(HC - FM)}{F^2 + M^2 + 2HC + (F + M)(H + C)}$$

Partition by land-surface types and beam filling

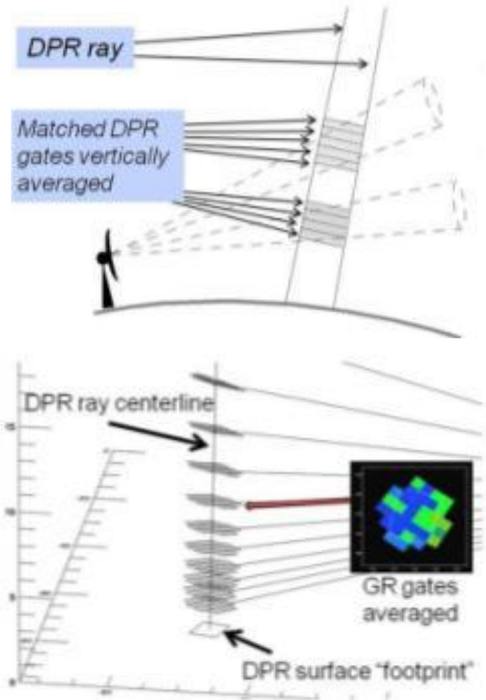




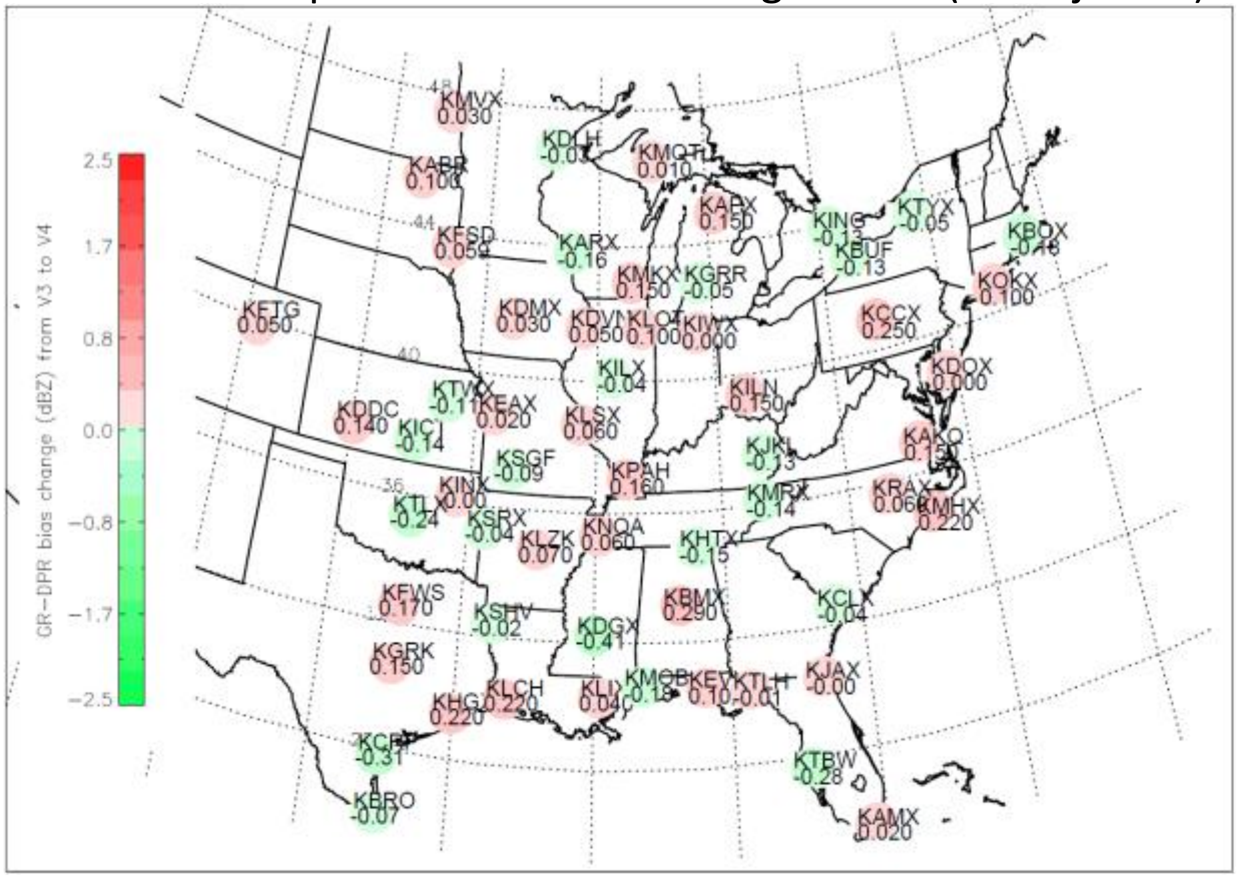
Courtesy P. Kierstetter

GPM Validation Network Architecture and DPR Ku V3, V4

VN Radar Architecture



Stratiform comparison in ice above bright band (Ku-adjusted)



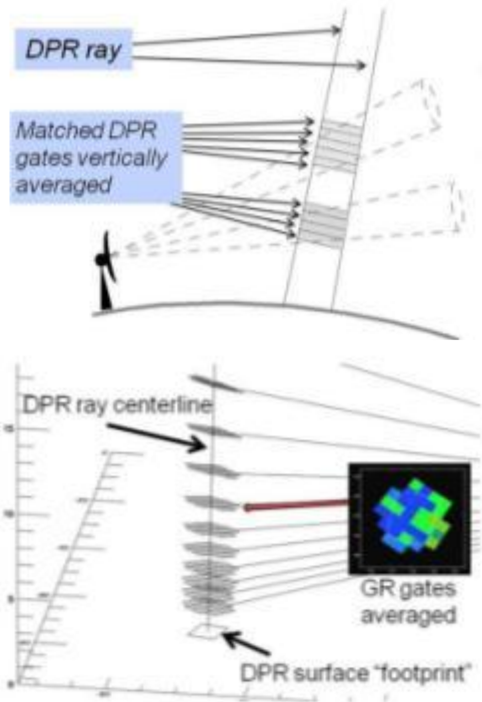
DPR + Select network and other research polarimetric radar 3-D geo-reference database
Profile Z_e-comparisons, DSD comparisons in liquid, Hydrometeor ID

Stratiform precip, ice above melting level: General agreement with DPR (within +/-2dB)

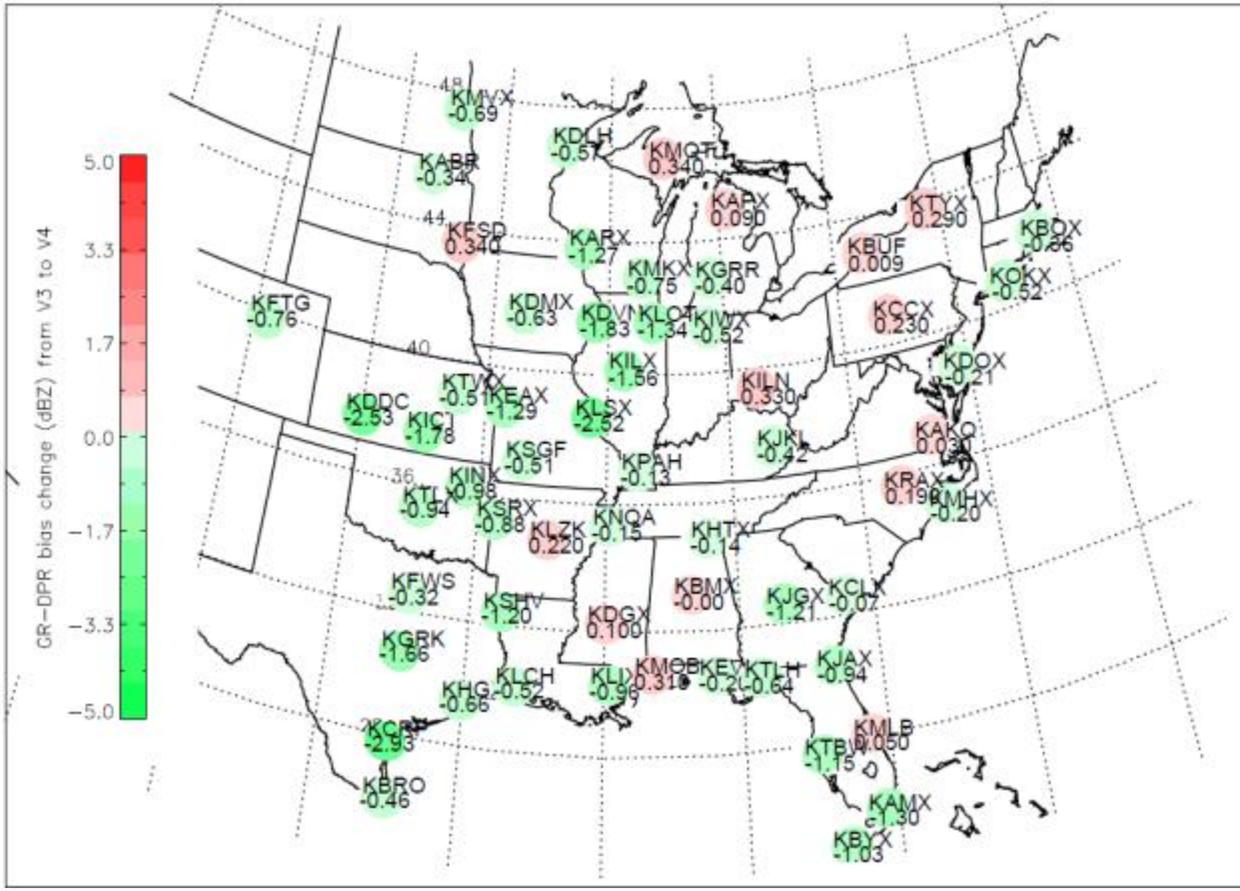
V3 88D tendency to be a little "cool" relative to DPR; looks to be a slight "warming" in V4

How is DPR performance in Convective Precip- especially at low levels?

VN Radar Architecture



Convective comparison in liquid/low-levels (Ku-adjusted)



General tendency for convective 2ADPR Z_{Ku} to be reduced at low levels in V3 relative to GR

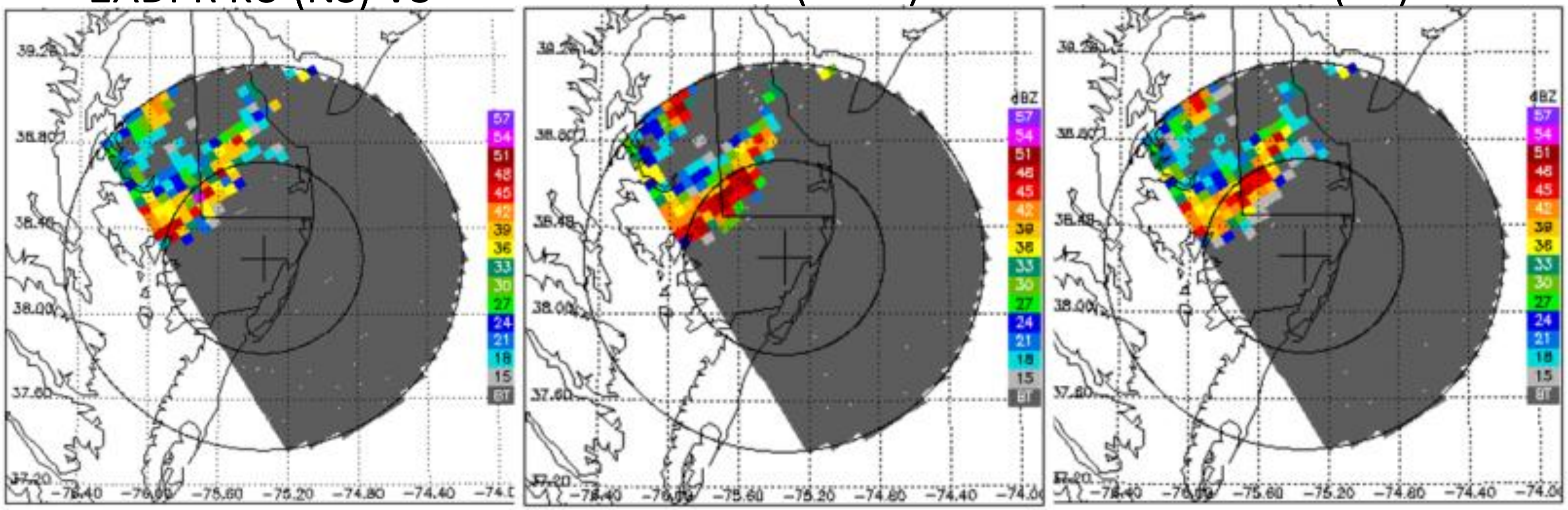
Situation for Z_{Ku} seems to be improved (in the mean) in preliminary V4 analysis

-Need to break this down a bit more by Ku PIA algorithms (e.g., NS, MS…)

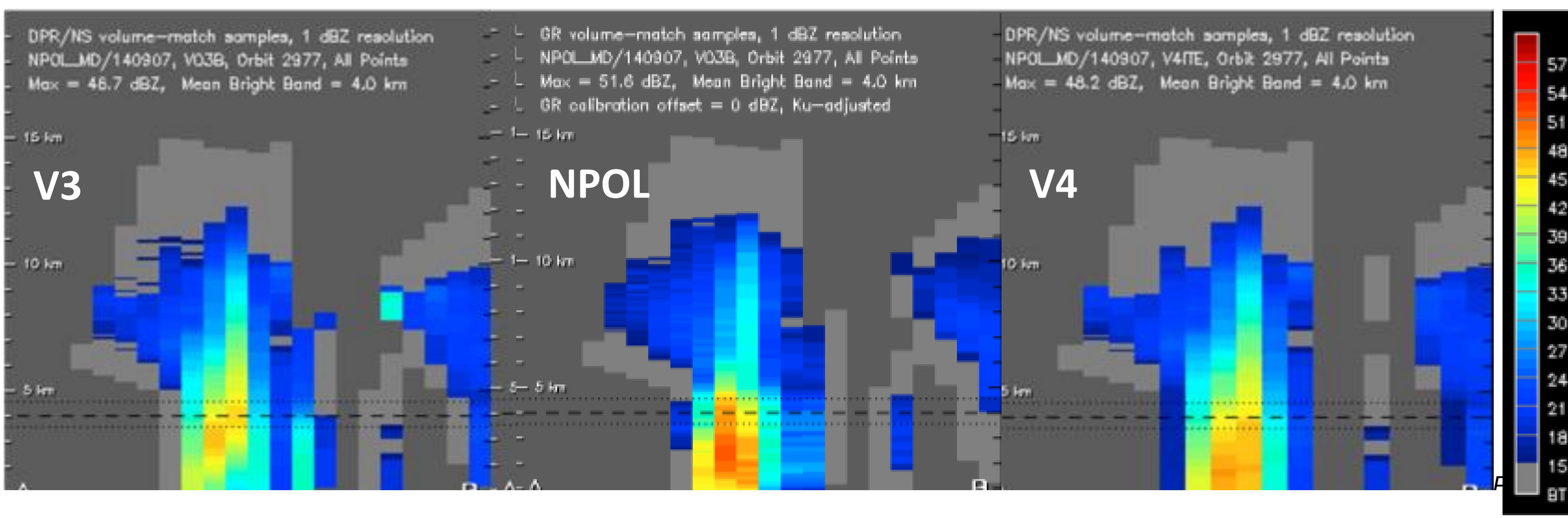
Case by Case Examination of Convective Impacts on DPR Products

DPR and NPOL 9/7/2014: Impacts of 3-D spatial variability and column processes?

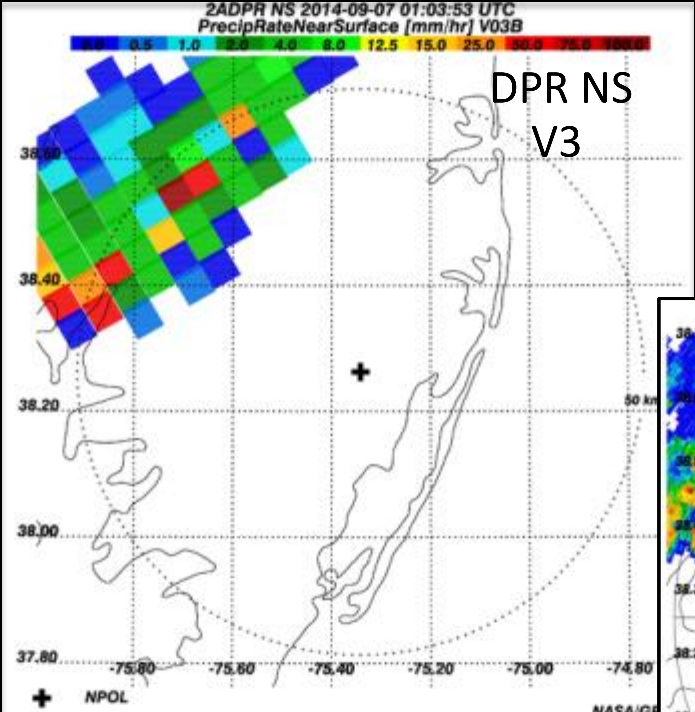
2ADPR KU (NS) V3 | NPOL (1.59°) | 2ADPR KU (NS) V4

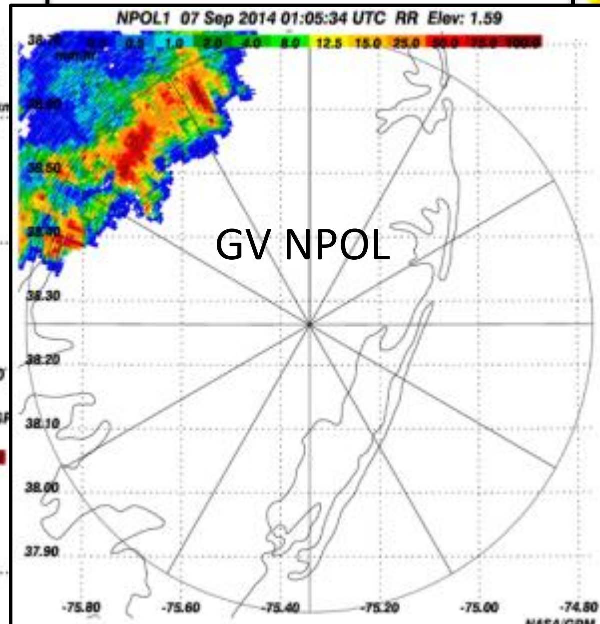


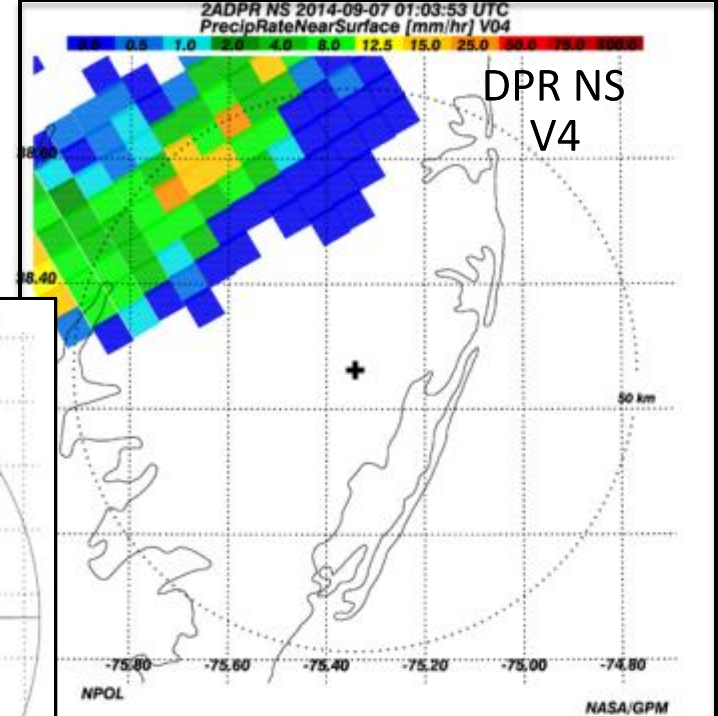
DPR Samples along NPOL RHI @ 331°

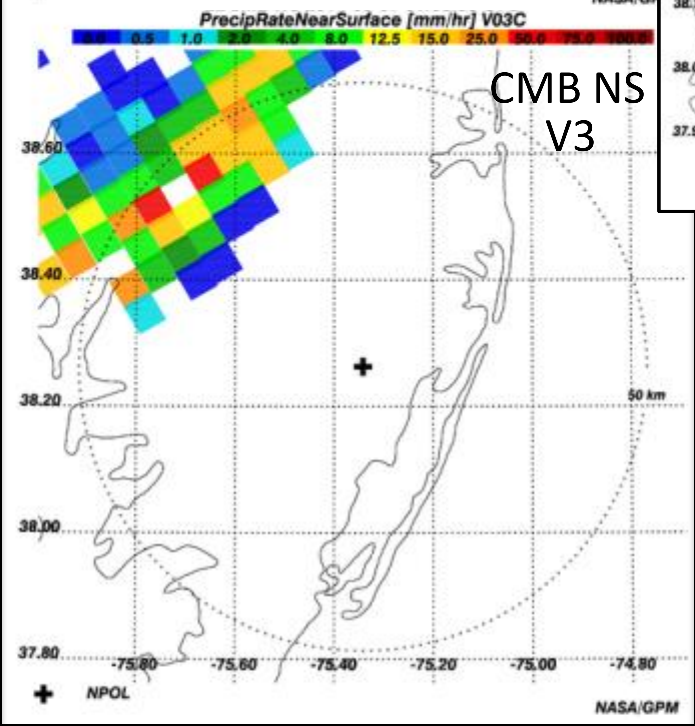


V3 vs. V4 DPR/CMB Rain Rates

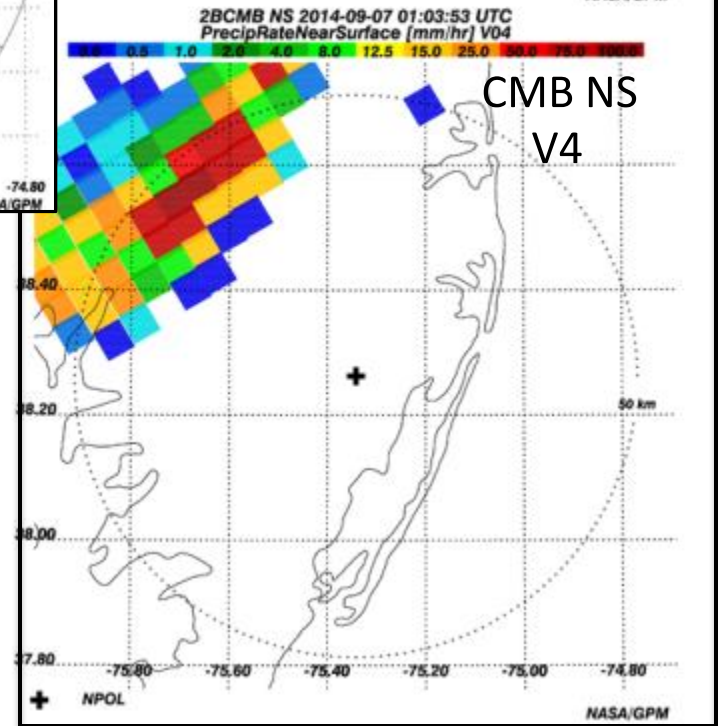






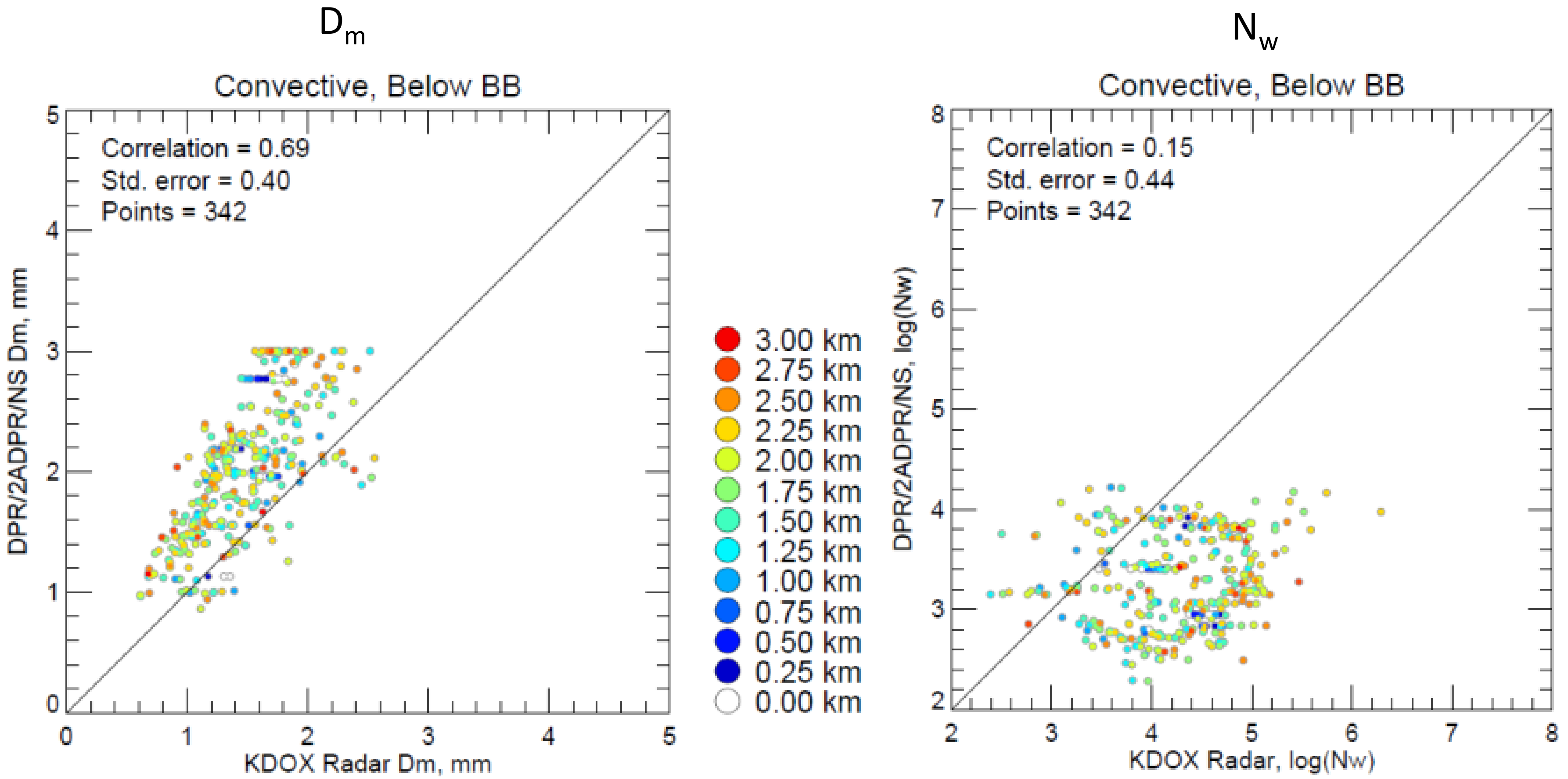


	Z	RR
DPR	↑	↓/↑
CMB NS	↑	↑



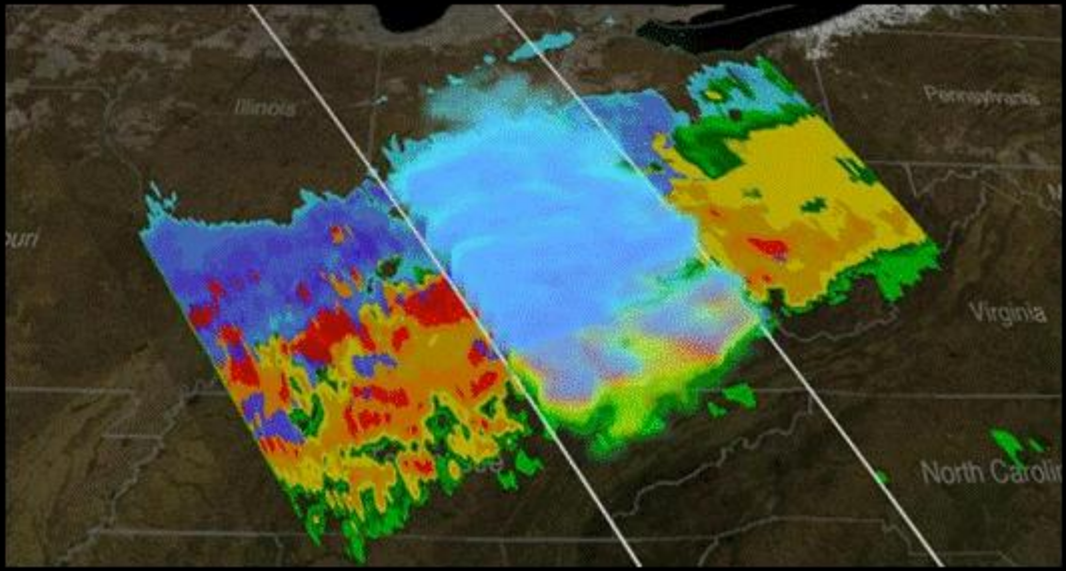
Associated DSD and changes?

V4 2ADPR vs. NPOL DSD



Task: Need to isolate/partition parameters in and between the algorithm version implementation(s) that are responsible for collective changes- more digging required..................

Snow- We CAN "detect" it!



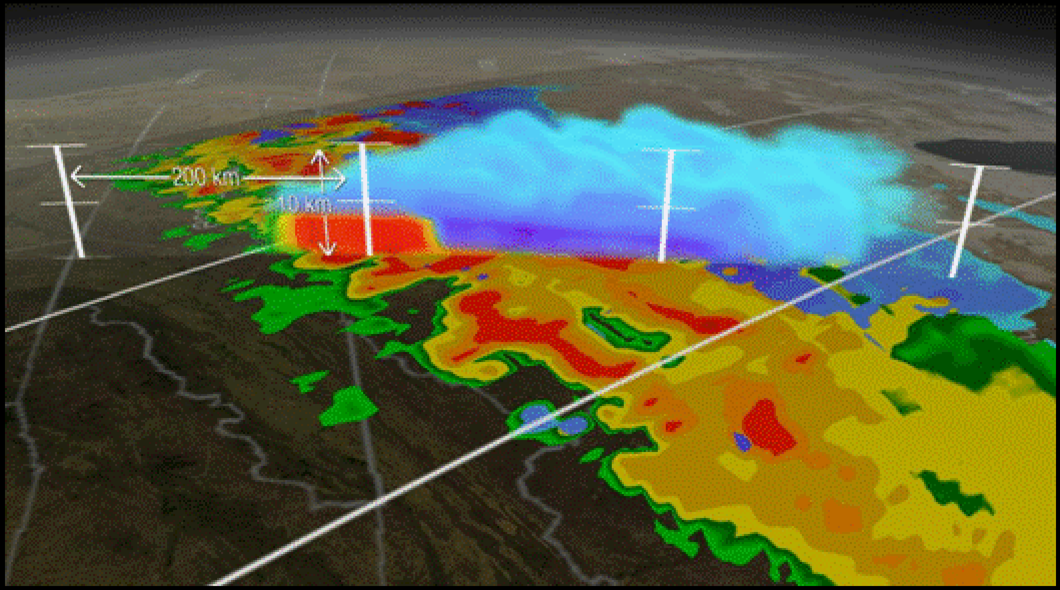
Winter storm with mix of liquid, freezing, frozen precipitation

GPROF and D3R delineate snow and rain……

But not always uniformly-

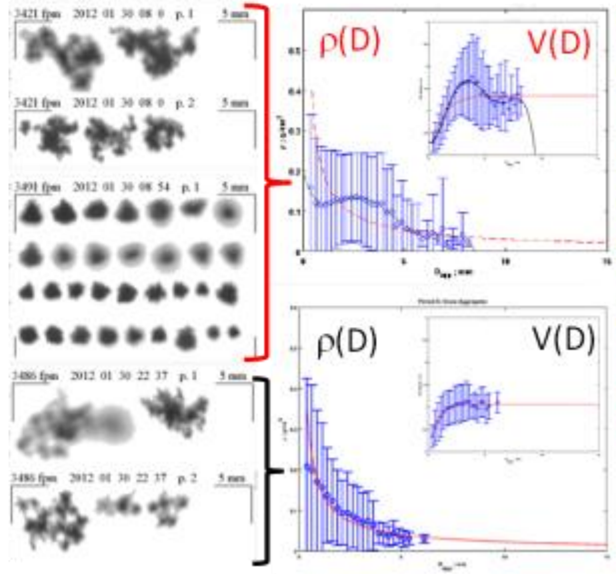
Can we adequately and routinely capture physical variability?

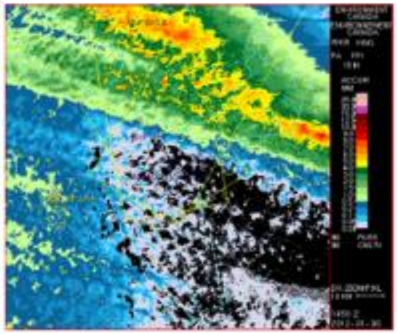
How well can we estimate SWER (threshold?)



Snow water equivalent rates- a case to case proposition!

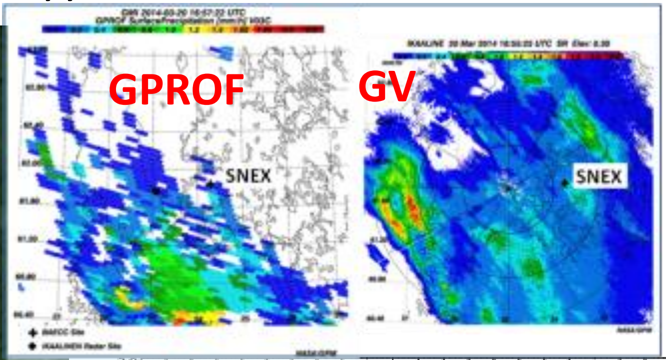
Approach: ρ-D adjustment and Z-S model (LPVEX) …..GCPEX: Intra-event Z-S variability - good SWER

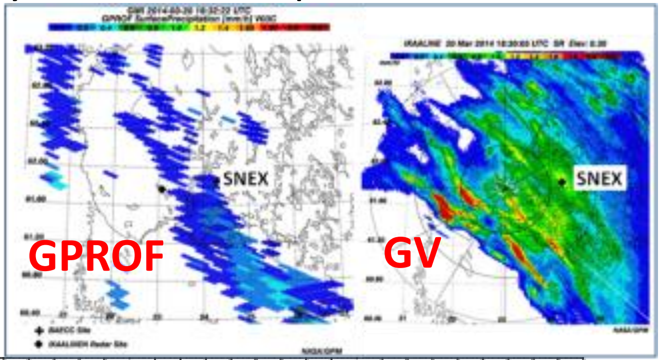


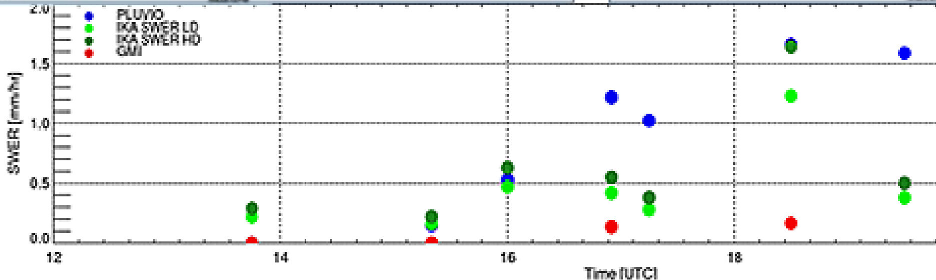


Period 1:
N(D)= 4473 exp(-1.19D)
$Z = 178\ SWER^{1.35}$
Period 2:
N(D) = 661 exp(-1.23D)
$Z = 235\ SWER^{1.74}$

Post-Launch: Finland, Hyytiala/SNEX Intra-event Variability w/GPM Overpass





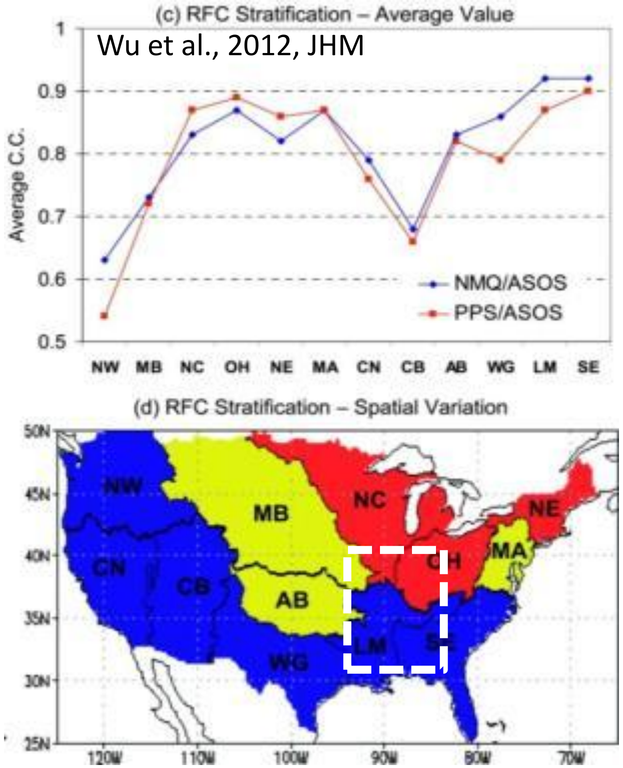


LPVEX (Finland) Z-SWE low/high ρ-regime used

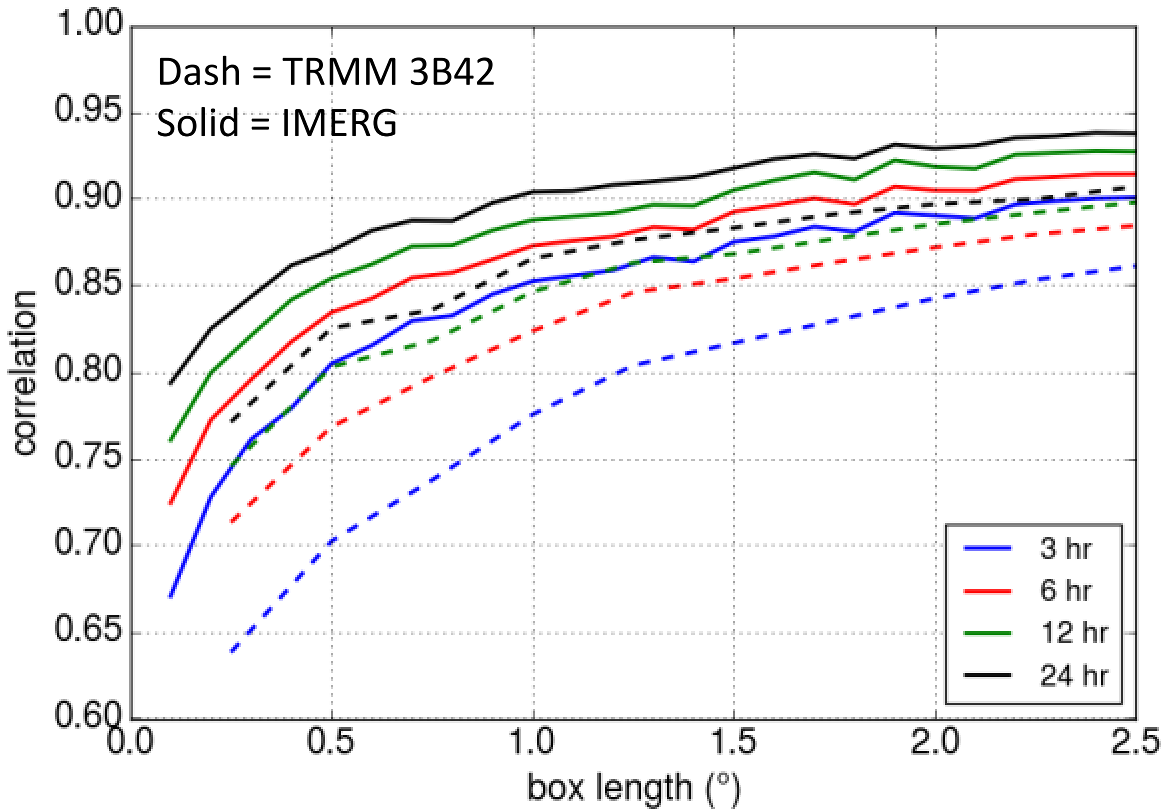
Integrated Validation: IMERGE Improves on 3B42

IMERG and 3B42 "Final" Products
Space-time correlation trends demonstrate improved GPM Product

Use "optimal" regions for GV (MRMS)



April – Nov. 2014
IMERGE (calibrated), 3B42 vs. (MRMS RQI = 1)

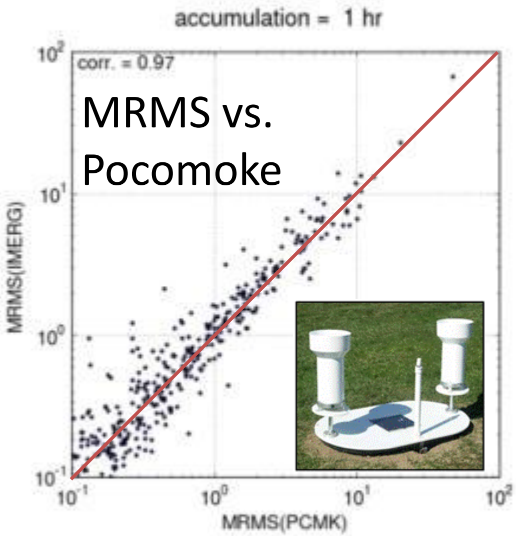


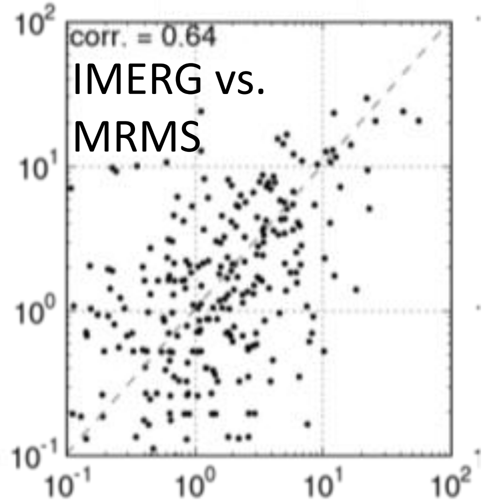
Performance trends as f(scale); How does this correlate to application impact?

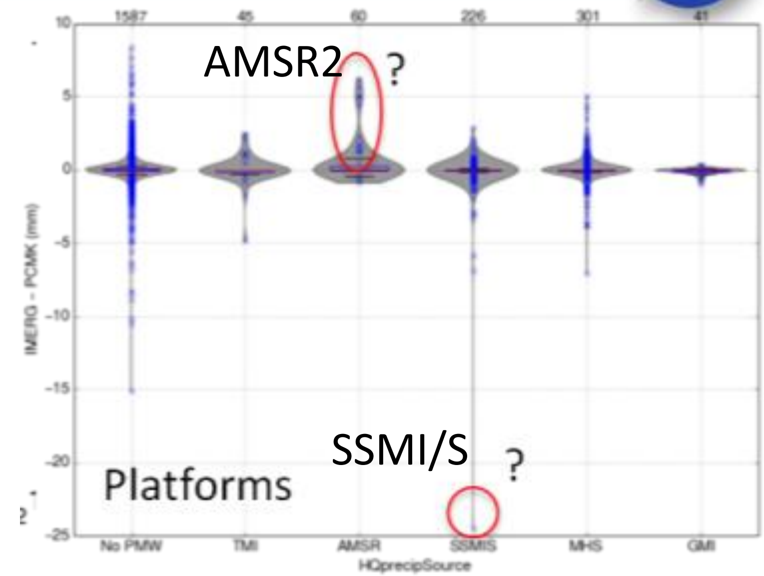
J. Tan (NPP, WFF)

GLOBAL PRECIPITATION MEASUREMENT

Bridging L2-L3: GV, MRMS, IMERG & Level II

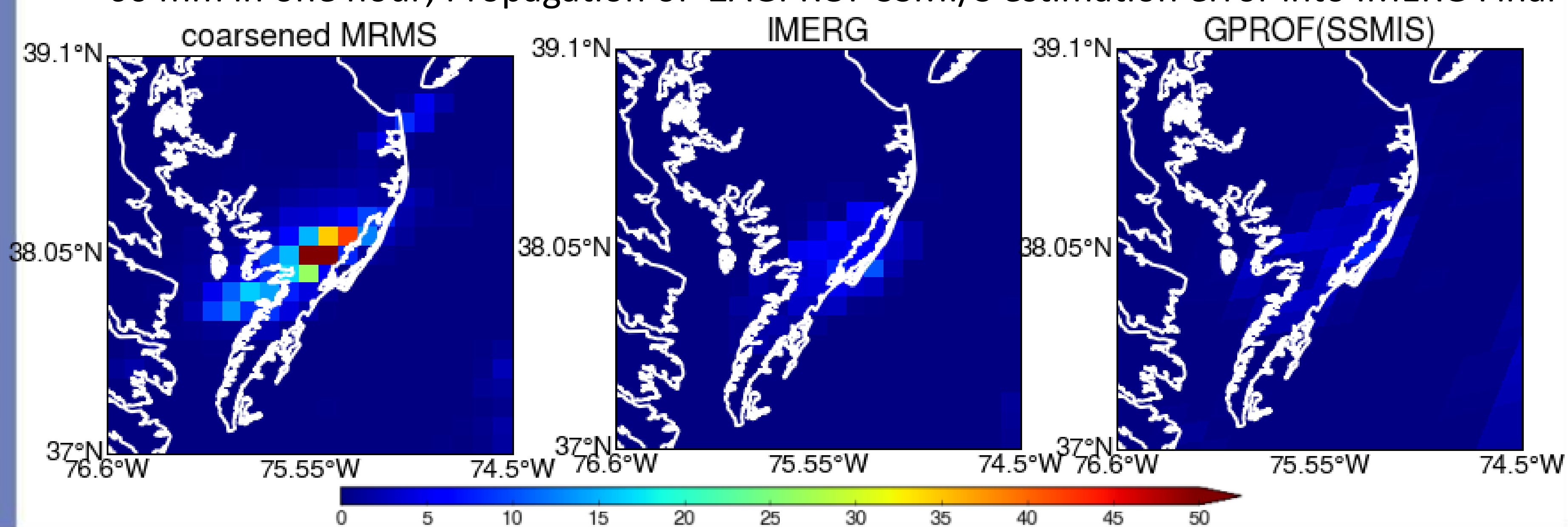






7/16/2015 Convective System:

~ 60 mm in one hour; Propagation of 2AGPROF SSMI/S estimation error into IMERG Final

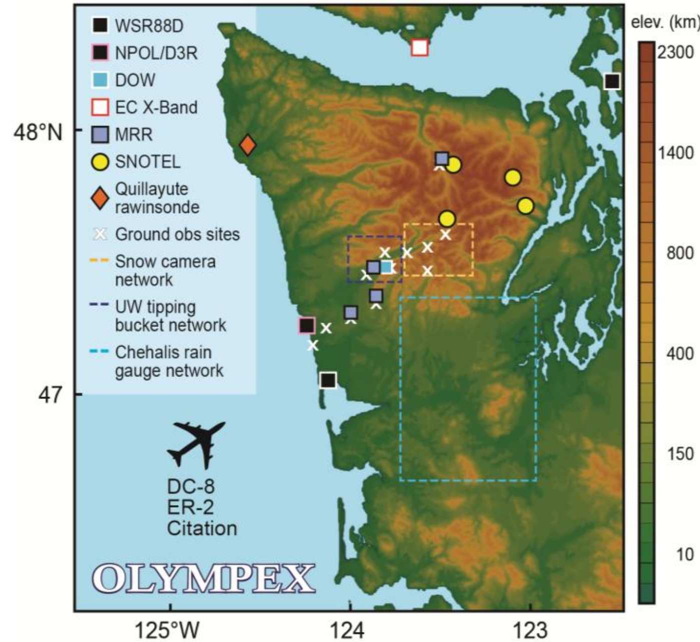


NASA GPM OLYMPEX Field Campaign
Olympic Mountains Experiment
No v 10, 2015 – Jan 15, 2016

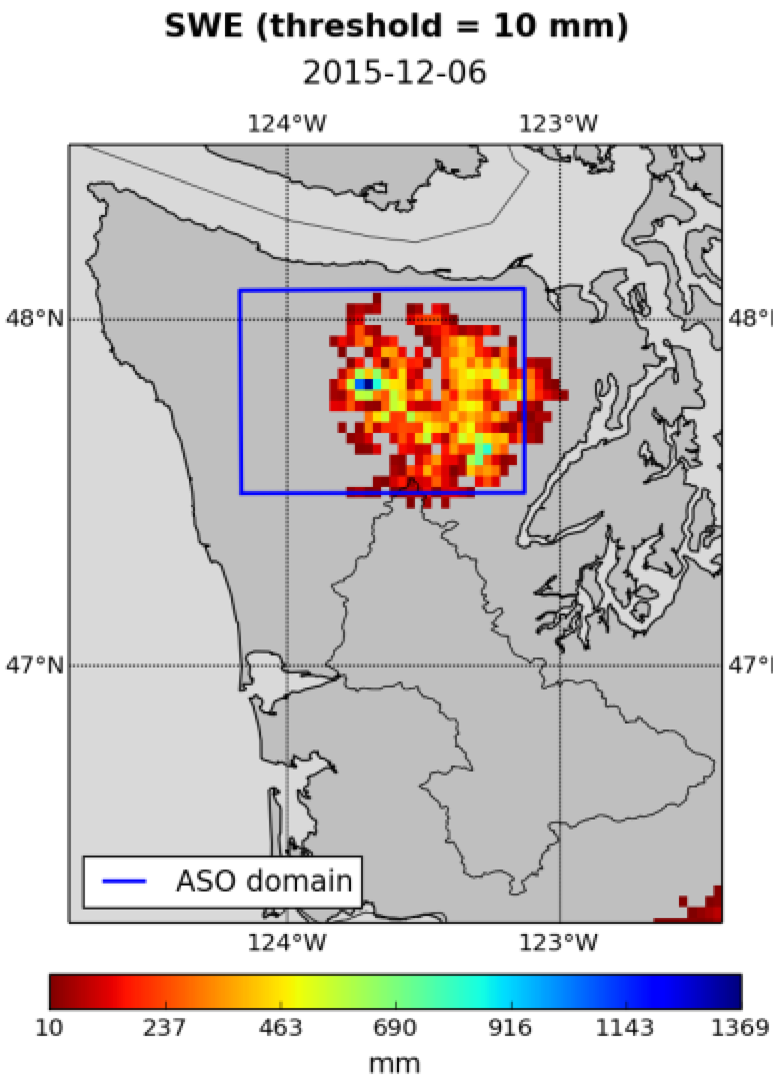
Science Goals:
- Physical Val. (rain, mixed, snow) in cold-season frontal precipitation in ocean to orographic gradient
- Level- IV product experimentation
- Testing of hydrologic applications
- ACE/RADEX Radar instrument and cloud physics

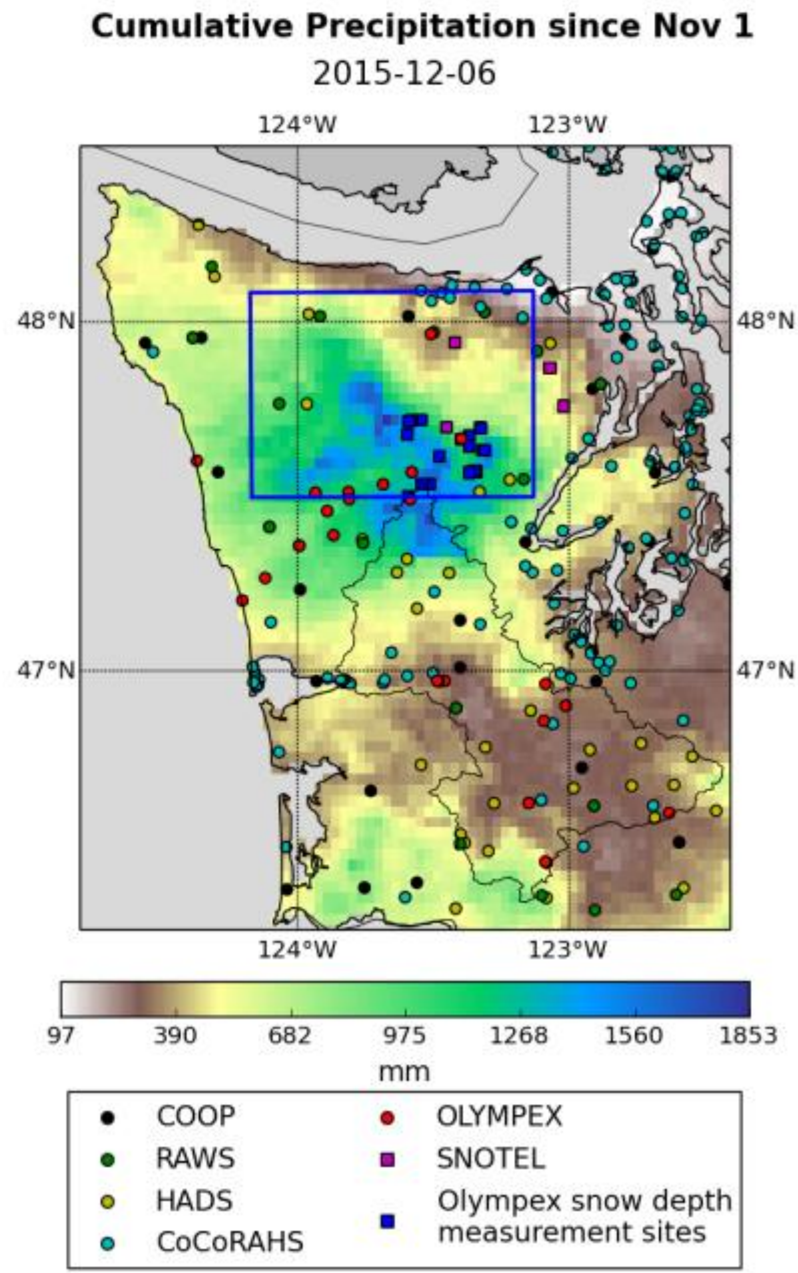
Instrumentation:
- Surface: Rain gauge networks on Quinault and Chehalis, SNOTEL, Snow cameras, Disdrometers, Pluvios, PIPs
- Soundings: AVAPS (DC-8) and Ground-based
- Radars: NPOL, D3R, EC-X, DOW, KLGX(88D)
- Aircraft: DC-8, Citation, ER-2 (ACE/RADEX): CoSMIR, AMPR , W, Ka, Ku , X-band radars, CPL, AirMSPI
- Airborne Snow Observatory flights planned

Status:
- In progress with unprecedented airborne and ground-based radar sampling of frontal system precipitation

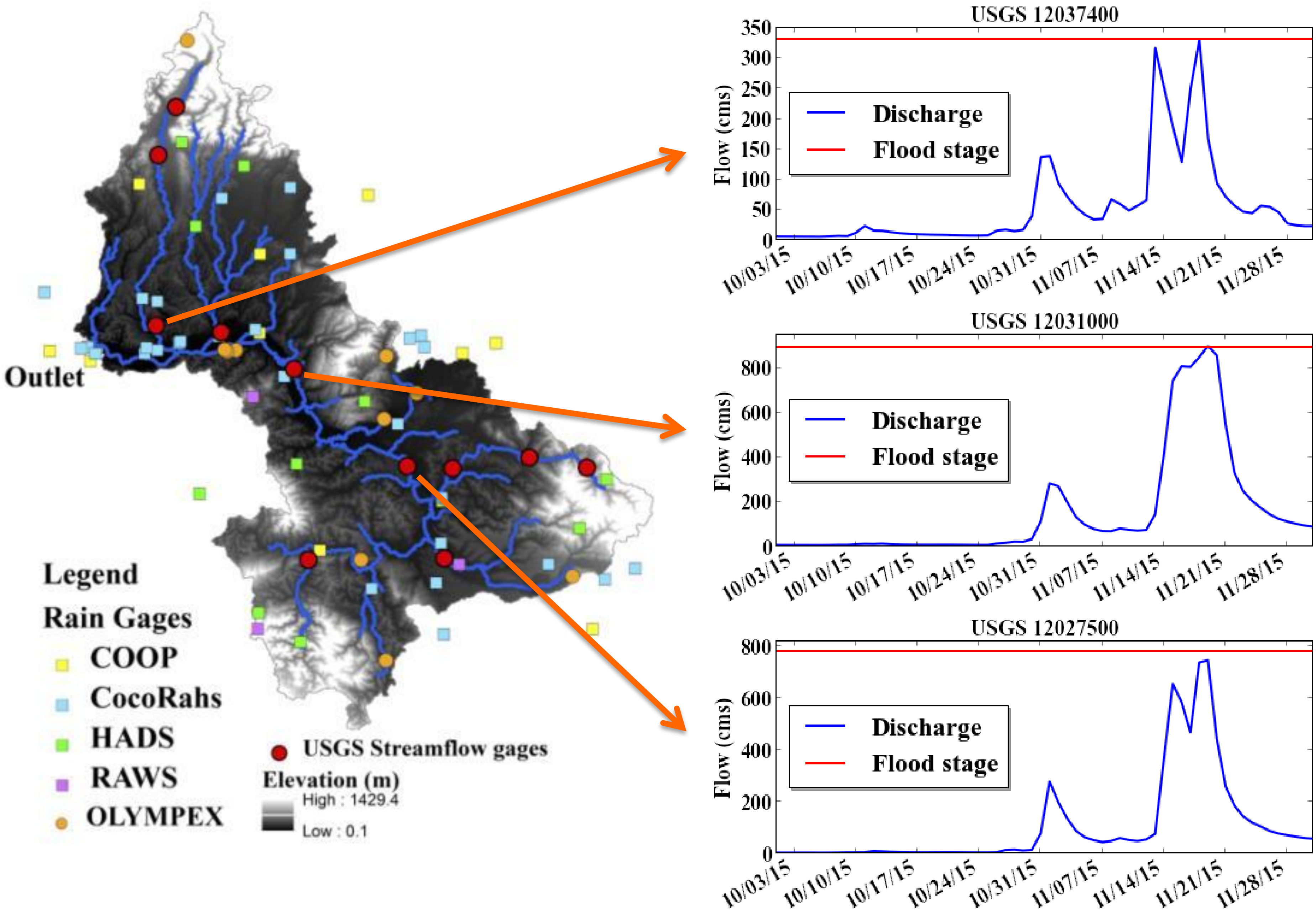


Olympex snow estimates and airborne snow observatory domain



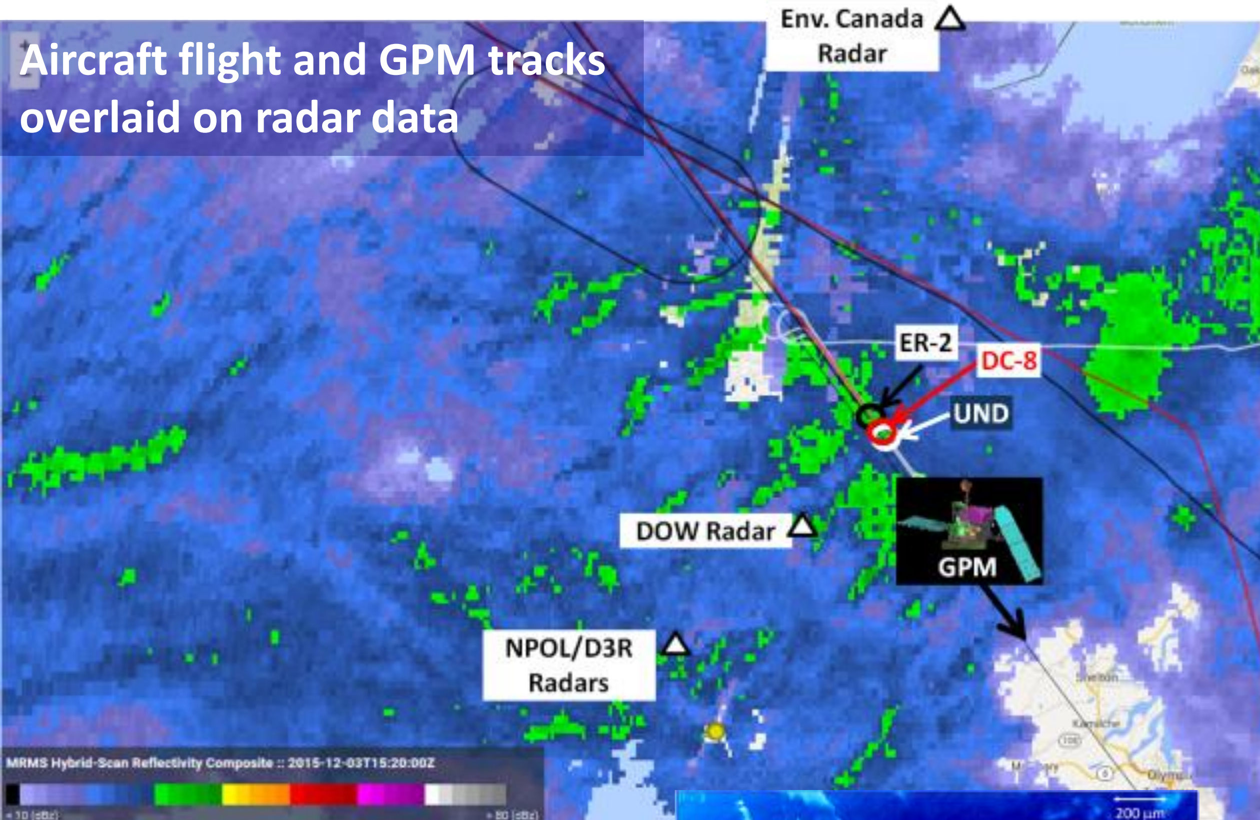


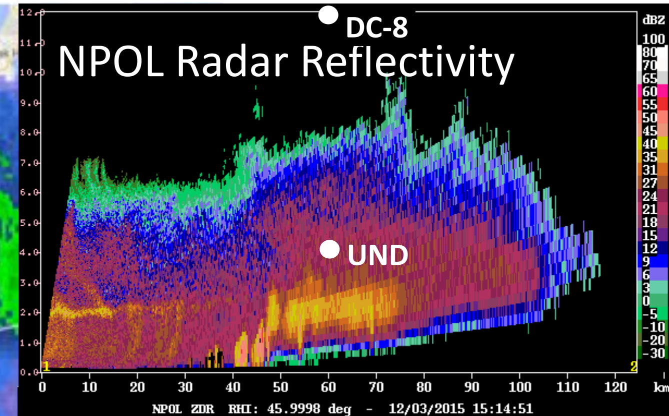
Olympex Chehalis River hydrologic observations and Nov. 2015 discharge

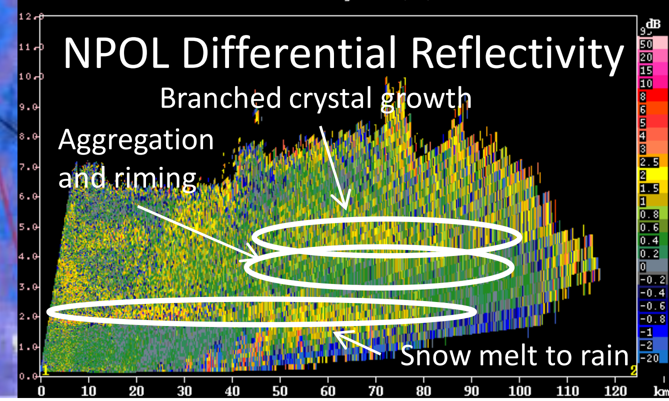


OLYMPEX Conducts first ever 3-aircraft stack (DC-8, ER-2, UND Citation) directly under the GPM Core satellite track within ground-based polarimetric radar coverage

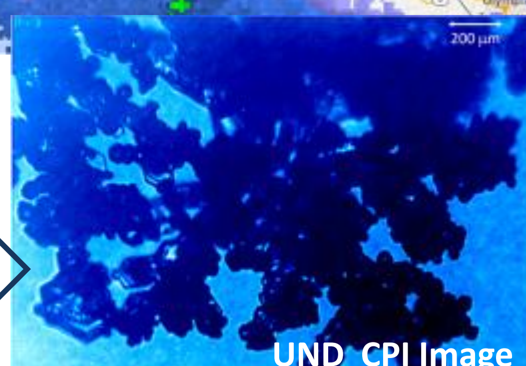
12/3/2015: A complex orographically-enhanced heavy precipitation event over the Olympic Mountains





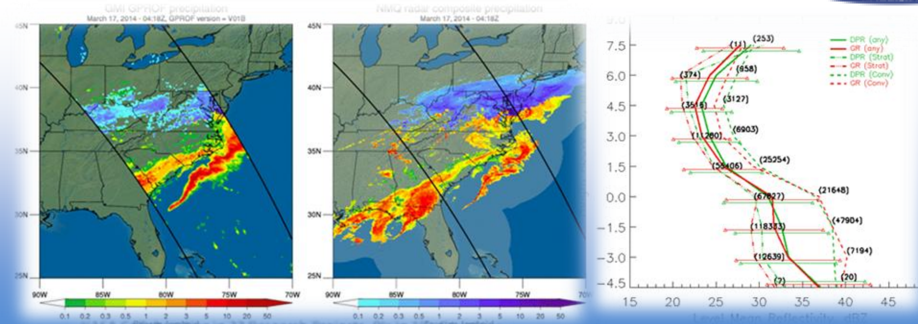


UND Citation cloud particle imager (CPI) observation, 4 km altitude. Indications of rimed (supercooled liquid water), branched and aggregated snow.

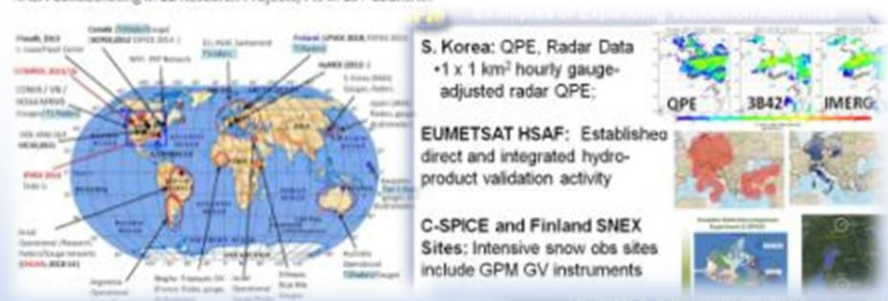


NPOL Radar vertical cross-sections across GPM satellite/aircraft tracks indicating snow crystal growth and aggregation process

Summary



- Post-launch first cut: GMI and DPR are performing well.
- Expect improvements with V4 in 2016
- **Level I Requirements assessment**



- "Drill down" in Direct GV
  - — Regimes (international!)
  - — Bridge Level II-III error propagation
  - — Snow (SWER), mixed and light rain
- Field and Tier-1 datasets to focus on column behavior, e.g., correlation structure, NUBF, complex mixed phase, light rain measurement

- Complete OLYMPEX campaign 2015/16
- Regime field campaign dataset analyses ["Build the column"]
- Integrated GV: Hydrologic analysis/application of GV and GPM datasets in existing and emerging tools/models (e.g., GFMS, NUWRF DA)